



**A SEMI-ANNUAL AQUATIC MONITORING REPORT FOR A
SURFACE MINE PERMIT (DMLR # 1101760) LOCATED NEAR
ROARING FORK IN WISE COUNTY, VIRGINIA**

**Prepared for:
Red River Coal Company, Inc**

**Authored by:
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ATS PROJECT NO. 1199.01

September 2012

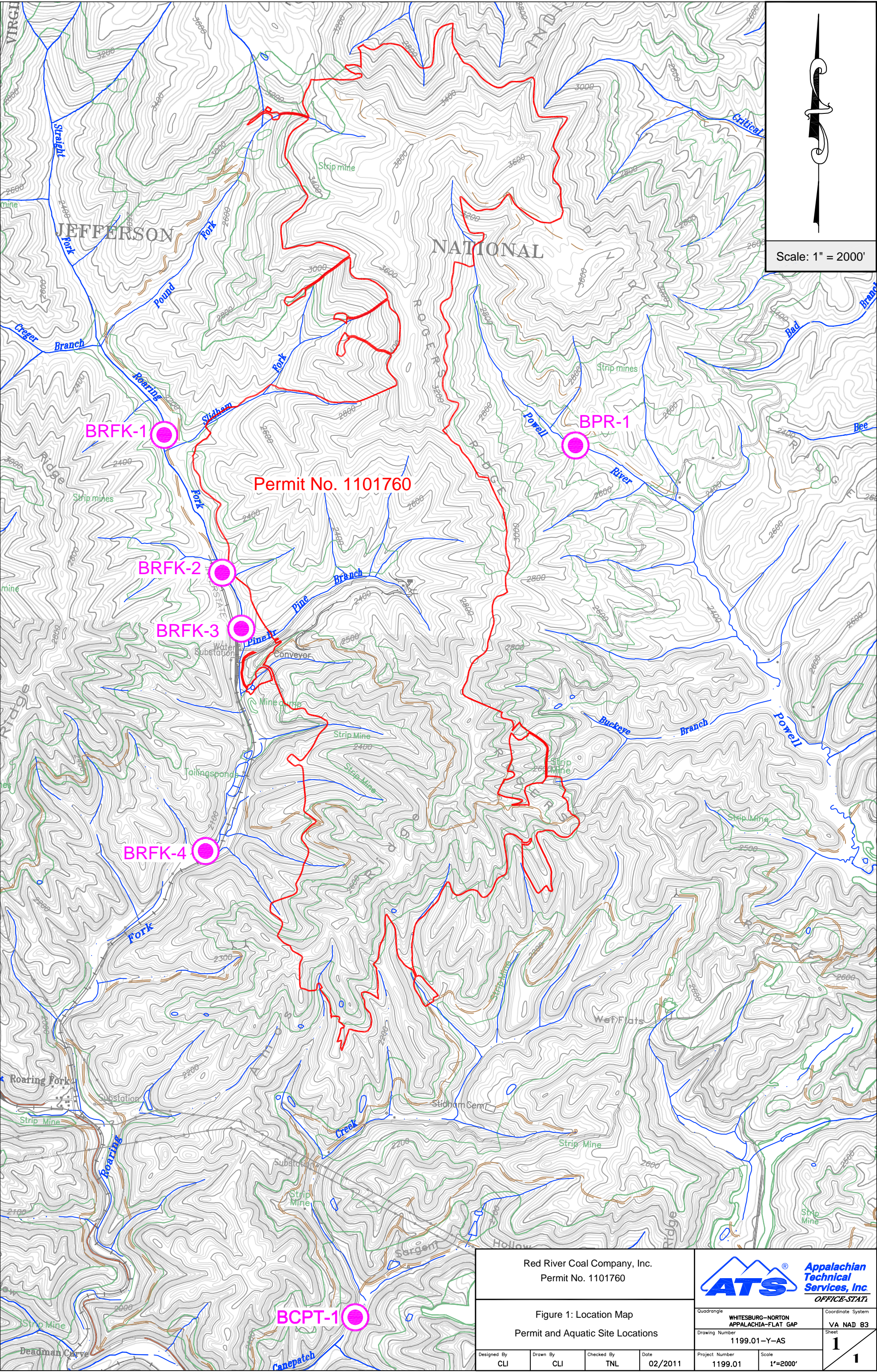
I. INTRODUCTION


Appalachian Technical Services, Inc. was contracted by Red River Coal Company, Inc to conduct ongoing semi-annual (spring and fall) aquatic monitoring at six sites near Roaring Fork in Wise County, Virginia. This report represents the fall 2012 aquatic biological assessments of six sample sites. The permit boundary and sample site locations are shown on the attached topographical map in Figure 1.

II. METHODS

General locations of all sample sites were selected by a Virginia DMLR biologist. However, the exact site locations may have been relocated by ATS senior biologists due to site conditions (*i.e.* low flow, lack of riffle habitat, etc.) and accessibility. Aquatic sampling site BRFK-1 was located on Roaring Fork approximately 50 m upstream of the confluence with Stidham Fork (37.01201; 82.72937). Aquatic sampling site BRFK-2 was located on Roaring Fork approximately 400 m upstream of sample site BFRK-3 (37.00596; 82.72571). Aquatic sampling site BRFK-3 was located on Roaring Fork approximately 50 m upstream of the confluence to Pine Branch (37.00011; 82.72237). Aquatic sampling site BRFK-4 was located southeast of the permit on Roaring Fork approximately 450 m downstream of a series of sediment ponds (39.98557; 82.72422). Aquatic sampling site BCPT-1 was southeast of the permit and located on Canepatch Creek approximately 100 m downstream of the confluence to Sargent Hollow (36.95584; 82.71094). Aquatic sampling site BPR-1 was located to the east of the permit boundary in the upper headwaters of the Powell River approximately 50 m upstream of Red River Coal Company's haulroad (37.01277; 82.69608).

Data collections for the aquatic monitoring consisting of habitat data, macroinvertebrates, grab sample and physiochemical water quality data were collected on 04 September 2012 by ATS Biological Technicians James Breeding and Brian Bledsoe.



Red River Coal Company, Inc. Permit No. 1101760				 Appalachian Technical Services, Inc. <i>OFFICE-STATION</i>	
Figure 1: Location Map Permit and Aquatic Site Locations				Quadrangle WHITESBURG-NORTON APPALACHIA-FLAT GAP	Coordinate System VA NAD 83
Designed By CLI				Drawing Number 1199.01-Y-AS	Sheet 1
Drawn By CLI				Project Number 1199.01	Scale 1"=2000'
Checked By TNL				Date 02/2011	1

A. Habitat Assessments

Rapid Bioassessment Protocol (RBP) high gradient data sheets were used to assess the habitat for each stream. The RBP sheets score each site's habitat based on 10 criteria with 1 - 20 possible points each (for a max total of 200). Based on the *2008 Methods for Assessing Biological Integrity of Surface Waters in Kentucky, Revision 3* (KDOW 2008), stream habitat in the central Appalachians Ecoregion is considered not supporting its designated use if the total score is less than or equal to 116 total points. Habitat must score 117 – 159 to achieve a partially supporting criterion. To qualify as fully supporting habitat, it must score at least 160 total points. Copies of the stream habitat data sheets are attached in Appendix A.

B. Aquatic Macroinvertebrates

Macroinvertebrates were collected using the single habitat approach as described in sections 7.1.1 and 7.3.1 of the *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition* (Barbour *et al.* 1999).

Macroinvertebrates were collected by agitating a riffle area of 0.25 meters in front of a standard size (500 Φ m mesh) kicknet. This process was repeated eight times to achieve 2 square meters of sample area. Upon collection, samples from each site were placed in individual containers of 95% ethyl alcohol, labeled, and returned to the lab.

Subsampling procedures followed methods within Appalachian Technical Services, Inc.'s Virginia Department of Environmental Quality approved *Quality Assurance Project Plan for Biological Monitoring, 2010* and resulted in the identification of approximately 110 ($\pm 10\%$) individuals. All macroinvertebrates were identified by a North American Benthological Society certified taxonomist to family level with the exception of Chironomidae and Oligochaeta.

Macroinvertebrate metrics were calculated based on the methods included in *A Stream Condition Index for Virginia Non-Coastal Streams* (Tetra Tech, Inc. 2003). ATS

biologists used the Ecological Data Application System (EDAS) to statistically rarify the samples to 110 organisms and calculate VSCI scores. The VSCI is used to compare streams to reference conditions to evaluate a streams current health. A stream must score a 61 or above to qualify as acceptable water quality. In order to calculate the VSCI the following metrics were calculated from the family level aquatic macroinvertebrate data: Taxa richness; Ephemeroptera, Plecoptera, Trichoptera (EPT) Index; Percent Ephemeroptera; Percent Plecoptera + Trichoptera (less Hydropsychidae); Percent Scrapers; Percent Chironomidae; Percent of top two dominant families; and Family Biotic Index (FBI). Tables with the macroinvertebrate data are attached in Appendix B.

C. Physiochemical Water Data

Prior to any field data collections, all handheld meters were calibrated. Four water quality parameters (specific conductance, dissolved oxygen, pH, and temperature) were analyzed using a handheld meter (YSI Pro Plus). Upon return to the lab all meters received a post-calibration check to ensure validity of all measurements recorded.

In addition to handheld meters, a surface water grab sample was collected at each sample site and delivered to Environmental Monitoring Inc. for analysis. Parameters analyzed were Acidity, Alkalinity (Bicarbonate), Alkalinity (Carbonate), Total Alkalinity, Hardness, Total Iron, Total Manganese, Nitrate, Nitrite, Total Cyanide, Total Dissolved Solids, Total Phenols, Total Suspended Solids, Total Boron, Total Magnesium, Total Aluminum, Total Antimony, Total Arsenic, Total Barium, Total Beryllium, Total Cadmium, Total Chromium, Total Cobalt, Total Copper, Total Lead, Total Nickel, Total Selenium, Total Silver, Total Thallium, Total Zinc, Total Mercury, Chloride, Sulfate, and Dissolved Organic Carbon. Grab sample analysis data can be found in Appendix C.

III. RESULTS

A. *Habitat Assessments*

The stream habitat at BRFK-1 scored 132 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 18 feet wide and characterized mostly by a series of riffles and runs (Figures 2 and 3). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The water was clear but there was moderate deposition of sediment within the streambed. The stream banks were moderately stable and with good riparian zones.

The stream habitat at BRFK-2 scored 127 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 18 feet wide and characterized mostly by a series of riffles and runs (Figures 4 and 5). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The water was clear but there was moderate deposition of sediment within the streambed. The stream banks were moderately stable but the right bank had a narrow riparian zone.

The stream habitat at BRFK-3 scored 130 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 18 feet wide and characterized mostly by a series of riffles and runs (Figures 6 and 7). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear and there was evidence of slight siltation within the streambed. The stream banks were moderately stable but the right bank had a narrow riparian zone.

The stream habitat at BRFK-4 scored 132 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 18 feet wide and characterized mostly by a series of riffles and runs (Figures 8 and 9). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The

coloration of the water was clear but there was evidence of moderate sedimentation within the streambed. Both stream banks had suboptimal vegetation and good riparian zones.

The stream habitat at BCPT-1 scored 124 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 12 feet wide and characterized mostly by a series of riffles and runs (Figures 10 and 11). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear but there was evidence of moderate sedimentation within the streambed. The stream banks were moderately unstable and with good riparian zones.

The stream habitat at BPR-1 scored 131 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 4 feet wide and characterized mostly by a series of runs and riffles (Figures 12 and 13). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear but there was evidence of moderate deposition of sediment within the streambed. The stream banks were unstable but with good riparian areas.

B. Macroinvertebrates

Sample site BPR-1 had the highest Taxa Richness (Tables 1 and 2). Sample site BRFK-1 had the lowest Taxa Richness (Tables 1 and 2). Sample site BPR-1 had the lowest FBI score (3.03), indicating excellent water quality with organic pollution unlikely (Table 2). FBI scores for the six sample sites indicated fairly poor (5.95) to excellent (3.03) water quality (Table 2). VSCI scores for the six aquatic sample sites ranged from a low of 23.61 (BRFK-1) to a high of 55.16 (BPR-1) (Table 2).

coloration of the water was clear but there was evidence of moderate sedimentation within the streambed. Both stream banks had suboptimal vegetation and good riparian zones.

The stream habitat at BCPT-1 scored 124 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 12 feet wide and characterized mostly by a series of riffles and runs (Figures 10 and 11). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear but there was evidence of moderate sedimentation within the streambed. The stream banks were moderately unstable and with good riparian zones.

The stream habitat at BPR-1 scored 131 of 200 (Appendix A), indicating the habitat is partially supporting its designated use. The stream was approximately 4 feet wide and characterized mostly by a series of runs and riffles (Figures 12 and 13). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear but there was evidence of moderate deposition of sediment within the streambed. The stream banks were unstable but with good riparian areas.

B. Macroinvertebrates

Sample site BPR-1 had the highest Taxa Richness (Tables 1 and 2). Sample site BRFK-1 had the lowest Taxa Richness (Tables 1 and 2). Sample site BPR-1 had the lowest FBI score (3.03), indicating excellent water quality with organic pollution unlikely (Table 2). FBI scores for the six sample sites indicated fairly poor (5.95) to excellent (3.03) water quality (Table 2). VSCI scores for the six aquatic sample sites ranged from a low of 23.61 (BRFK-1) to a high of 55.16 (BPR-1) (Table 2).



Figure 2: BRFK-1 upstream view



Figure 3: BRFK-1 downstream view



Figure 4: BRFK-2 upstream view



Figure 5: BRFK-2 downstream view



Figure 6: BRFK-3 upstream view



Figure 7: BRFK-3 downstream view



Figure 8: BRFK-4 upstream view



Figure 9: BRFK-4 downstream view



Figure 10: BCPT-1 upstream view



Figure 11: BCPT-1 downstream view



Figure 12: BPR-1 upstream view



Figure 13: BPR-1 downstream view

Literature Cited

- Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.
- Kentucky Division of Water (KDOW), 2008. Methods for assessing biological integrity of surface waters in Kentucky, Revision 3. Kentucky Department of Environmental Protection, Division of Water, Frankfort, Kentucky.
- Tetra Tech, Inc. 2003. A Stream Condition Index for Virginia Non-Coastal Streams. Tetra Tech, Inc. Owings Mills, Maryland. Prepared for Virginia Department of Environmental Quality, Richmond, Virginia.

APPENDIX A:

RBP DATA

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BPRI Ecoregion: _____ Land Use: Mining
 Field Team: JEB, BWB Survey Reason: Bio. monitoring Start Time: 15:00
 Stream Name: Bowell River Location: 50m above road crossing Finish Time: 15:25

Date: 9/4/12 Latitude: 37.01277 Longitude: 82.69608
 Stream Physicochemical

Instrument ID number: VSL-PRO pH: 8.29
 Temperature: 18.5 °C Conductivity: 1140 µS/cm
 Dissolved Oxygen: 8.47 mg/l Did instrument pass all post-calibration checks? Y PH out = 0.38
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Poor Banks None
 Habitats sampled (circle one) Riffle Snags Snags Snags Vegetation
 # jabs _____ Area Sampled (sq. m): 2m²

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED

FEATURES:
 Stream Width 4.0 ft
 Range of Depth 1.0 ft
 Average Velocity _____ f/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☐ Surface Mining ☐ Construction ☐ Forest
☐ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type:
☒ Trees ☐ Shrubs
☐ Grasses ☐ Herbaceous
 Number of strata 3

Dom. Tree/Shrub Taxa

Hoplar
Buckeye
Willow

Canopy Cover:

☐ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ Full ☐ Partial

Substrate 0 Est. 0P.C.

Riffle 70 %

Run 25 %

Pool 5 %

High Gradient Habitat Data Sheet

1. Epifaunal

Substrate/Available Cover

Optimal

Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transients).

Suboptimal

40-70% m/s of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).

Marginal

20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.

Poor

Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

2. Embeddedness

Optimal

Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.

Suboptimal

Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.

Marginal

Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.

Poor

Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

3. Velocity/Depth Regime

Optimal

Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5

Suboptimal

Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).

Marginal

Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).

Poor

Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

4. Sediment Deposition	Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of	Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent.
SCORE	20 19 18 17 16 m/s.	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Poor Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Channel Alteration	Optimal Channelization or dredging absent or minimal; stream with normal pattern.	Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15.	Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25.	Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Poor Unstable; many eroded areas "raw" areas.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)	Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
SCORE				131

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BRFK1 Ecoregion: _____ Land Use: mining
 Field Team: JER, BWB Survey Reason: Bio. Monitoring Start Time: 14:00
 Stream Name: Roaring Fork Location: Adjacent to railroad truck Finish Time: 14:36

Date: 9/4/12 Latitude: 37.01201 Longitude: 82.72937
 Stream Physicochemical

Instrument ID number: YSE-R20 pH: 8.25
 Temperature: 18.1 °C Conductivity: 1338 µS/cm
 Dissolved Oxygen: 9.10 mg/l Did instrument pass all post-calibration checks? Y NO PH OUT = 0.38
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (circle one) Good Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Riffle Marginal Snags Poor Banks None Vegetation Area Sampled (sq.m): 2m²
 Habitats sampled (circle one) # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other _____
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 18 ft
 Range of Depth 1.5 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☐ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☒ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Rhododendron
☒ Trees ☒ Shrubs magnolia
☐ Grasses ☐ Herbaceous Birch
 Number of strata 3 Hemlock

Canopy Cover:

☒ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ Full ☐ Partial

Substrate Est. OP.C. _____

Riffle 40 %

Run 55 %

Pool 5 %

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Available Cover

Optimal	Suboptimal	Marginal	Poor
Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not now fall and not transitory).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

2. Embeddedness

Optimal	Suboptimal	Marginal	Poor
Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

3. Velocity/Depth Regime

Optimal	Suboptimal	Marginal	Poor
Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

4. Sediment Deposition	Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of	Poor Heavy deposits of fine material; increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent.
SCORE	20 19 18 17 16 m/s.	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Poor Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Channel Alteration	Optimal Channelization or dredging absent or minimal; stream with normal pattern.	Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted; instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15.	Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25.	Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Poor Unstable; many eroded areas "raw" areas
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)	Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
SCORE				

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BREF2 Ecoregion: _____ Land Use: Mining
 Field Team: JEB, BWD Survey Reason: Bio. Monitoring Start Time: 13:10
 Stream Name: Roaring Fork Location: Adjacent to haul road Finish Time: _____

Date: 9/14/12 Latitude: 37.00596 Longitude: 82.72571
 Stream Physicochemical

Instrument ID number: YSI-620 pH: 8.40
 Temperature: 20.0 °C Conductivity: 1388 µS/cm
 Dissolved Oxygen: 8.90 mg/l Did instrument pass all post-calibration checks? YIN PHENOT = 0.38
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Poor None
 Habitats sampled (circle one) Riffle Snags Banks Vegetation Area Sampled (sq. m): 2m²
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 18 ft
 Range of Depth 1.0 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☐ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Boreal
☒ Trees ☐ Shrubs
☒ Grasses ☐ Herbaceous
 Number of strata 4
Hemlock
Autumnal

Canopy Cover:

☐ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☒ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ (Full) ☐ Partial

Substrate Est. OP.C.

Riffle 55 %

Run 45 %

Pool 0 %

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Available Cover

Optimal	Suboptimal	Marginal	Poor
Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16

2. Embeddedness

Optimal	Suboptimal	Marginal	Poor
Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16

3. Velocity/Depth Regime

Optimal	Suboptimal	Marginal	Poor
Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

4. Sediment Deposition	Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of	Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent.
SCORE	20 19 18 17 16 m/s.	15 14 13 12 11	⑩ 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Poor Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	⑮ 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Channel Alteration	Optimal Channelization or dredging absent or minimal; stream with normal pattern.	Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 ⑪	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15.	Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25.	Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%.
SCORE	20 19 18 17 16	15 14 13 ⑫ 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Poor Unstable; many eroded areas "raw" areas
SCORE RB	10 9	8 7 6	⑤ 4 3	2 1 0
SCORE LB	10 9	8 ⑦ 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height.
SCORE RB	10 9	⑧ 7 6	5 4 3	2 1 0
SCORE LB	10 9	⑧ 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)	Optimal Width of riparian zone >18 m; human activities, (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
SCORE RB	10 9	8 7 6	⑤ 4 3	2 1 0
SCORE LB	10 ⑨	8 7 6	5 4 3	2 1 0
SCORE				127

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BRFK3 Ecoregion: _____ Land Use: Mining
 Field Team: JEB, BWB Survey Reason: Bio. Monitoring Start Time: 12:25
 Stream Name: Roaring Fork Location: Adjacent to old coke ovens Finish Time: 12:50

Date: 9/4/12 Latitude: 37.00011 Longitude: 82.72237
 Stream Physicochemical

Instrument ID number: VSI-R80 pH: 8.45
 Temperature: 19.3 °C Conductivity: 1366 µS/cm
 Dissolved Oxygen: 8.88 mg/l Did instrument pass all post-calibration checks? Y/N PH OUT = 0.38
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Poor Banks None Vegetation
 Habitats sampled (circle one) Riffle Snags Area Sampled (sq. m): 2m2
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other _____
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 18 ft
 Range of Depth 1.0 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☐ Surface Mining ☐ Construction ☐ Forest
☐ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal ☐ High
☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominate Type: Sycamore
☐ Trees ☐ Shrubs Poplar
☐ Grasses ☐ Herbaceous Red maple
 Number of strata 3

Canopy Cover:

☐ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☒ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ (Full) ☐ (Partial)

Substrate Est. OP.C.

Riffle 80 %

Run 20 %

Pool 0 %

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Available Cover

Optimal	Suboptimal	Marginal	Poor
Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

2. Embeddedness

Optimal	Suboptimal	Marginal	Poor
Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

3. Velocity/Depth Regime

Optimal	Suboptimal	Marginal	Poor
Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

4. Sediment Deposition	Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of	Poor Heavy deposits of fine material; increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent.
SCORE	20 19 18 17 16 n/s.	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Poor Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Channel Alteration	Optimal Channelization or dredging absent or minimal; stream with normal pattern.	Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted; instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15.	Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25.	Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Poor Unstable; many eroded areas "raw" areas
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)	Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199-01-BRFK4 Ecoregion: _____ Land Use: Mining
 Field Team: JEB, BNB Survey Reason: Bio. Monitoring Start Time: 11:00
 Stream Name: Boaring Fork Location: Adjacent to haul rd. & rail road tracks Finish Time: 11:35

Date: 9/4/12 Latitude: 36.98557 Longitude: 82.72422
 Stream Physicochemical

Instrument ID number: YST-PRO pH: 8.32
 Temperature: 18.8 °C Conductivity: 1363 µS/cm
 Dissolved Oxygen: 8.91 mg/l Did instrument pass all post-calibration checks? Y
 If NO - which parameter(s) failed and action _____ **PH OUT = 0.38**

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Poor Banks Non-Vegetation
 Habitats sampled (circle one) Riffle Snags Area Sampled (sq. m): 2m²
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other _____
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 18 ft
 Range of Depth 3.5 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☐ Surface Mining ☐ Construction ☐ Forest
☐ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal ☐ High
☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Decid. Tree/Shrub Taxa
☒ Trees ☐ Shrubs Aspen
☐ Grasses ☐ Herbaceous Sycamore
 Number of strata 3 Poplar

Canopy Cover:

☐ Fully Shaded (75-100%)
☒ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ (Full) ☐ (Partial)

Substrate Est. OP.C.

Riffle 35 %

Run 60 %

Pool 5 %

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Available Cover

Optimal	Suboptimal	Marginal	Poor
Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

2. Embeddedness

Optimal	Suboptimal	Marginal	Poor
Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

3. Velocity/Depth Regime

Optimal	Suboptimal	Marginal	Poor
Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

4. Sediment Deposition		Optimal	Suboptimal	Marginal	Poor
		Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of	Heavy deposits of fine material; increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent.
SCORE		20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status		Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Poor Very little water in channel and mostly present as standing pools.
SCORE		20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Channel Alteration		Optimal Channelization or dredging absent or minimal; stream with normal pattern.	Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted; instream habitat greatly altered or removed entirely.
SCORE		20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)		Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15.	Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25.	Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%.
SCORE		20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)		Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Suboptimal Moderately stable; infrequent; small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Poor Unstable; many eroded areas "raw" areas
SCORE RB		10 9	8 7 6	5 4 3	2 1 0
SCORE LB		10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)		Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height.
SCORE RB		10 9	8 7 6	5 4 3	2 1 0
SCORE LB		10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)		Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
SCORE RB		10 9	8 7 6	5 4 3	2 1 0
SCORE LB		10 9	8 7 6	5 4 3	2 1 0

SCORE

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Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BCPT1 Ecoregion: _____ Land Use: mining

Field Team: JEB, BWB Survey Reason: Bio. monitoring Start Time: 9:40

Stream Name: Care Patch Location: 100m below pond Finish Time: 10:25

Date: 9/14/12 Latitude: 36.95584 Longitude: 82.71094

Stream Physicochemical

Instrument ID number: YSI-PRO pH: 8.27

Temperature: 21.0 °C Conductivity: 959 µS/cm

Dissolved Oxygen: 8.47 mg/l Did instrument pass all post-calibration checks? Y/N PH OUT = 0.38

If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)

Riffle Quality (circle one) Good Marginal Poor None

Habitats sampled (circle one) Riffle Snags Banks Vegetation Area Sampled (sq. m): 2m²

Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy

Recent precipitation (circle one) Clear Showers Rain Storms Other

Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 12 ft

Range of Depth 2.0 ft

Average Velocity _____ ft/s

Discharge _____ cfs

Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☐ Surface Mining ☐ Construction ☐ Forest

☐ Deep Mining ☐ Commercial ☐ Pasture/Grazing

☐ Oil Wells ☐ Industrial ☐ Silviculture

☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments

☐ Island ☐ Waterfalls

☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☐ Normal

☐ High ☐ Very Rapid or Torrential

Stream Type:

☐ Perennial ☐ Intermittent

☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Roadside

☒ Trees ☒ Shrubs Hemlock

☐ Grasses ☒ Herbaceous Buckeye

Number of strata 3 Sycamore

Canopy Cover:

☐ Fully Shaded (75-100%)

☒ Partially Shaded (50-75%)

☐ Partially Exposed (25-50%)

☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging

☐ Channelization

☐ (Full) ☐ (Partial)

Substrate Est. OP.C.

Riffle 45%

Run 55%

Pool 0%

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Avaliable Cover

Optimal

Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transitory).

Suboptimal

40-70% m/s of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).

Marginal

20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.

Poor

Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

2. Embeddedness

Optimal

Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.

Suboptimal

Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.

Marginal

Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.

Poor

Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

3. Velocity/Depth Regime

Optimal

Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5

Suboptimal

Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).

Marginal

Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).

Poor

Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

	Optimal	Suboptimal	Marginal	Poor
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent.
SCORE	20 19 18 17 16 mts.	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Flow Status	Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Poor Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Channel Alteration	Optimal Channelization or dredging absent or minimal; stream with normal pattern.	Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted.	Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted, instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15.	Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25.	Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Bank Stability (score each bank)	Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Poor Unstable; many eroded areas "raw" areas
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank)	Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally.	Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal.	Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities.
SCORE RB	10 9	8 7 6	5 4 3	2 1 0
SCORE LB	10 9	8 7 6	5 4 3	2 1 0

SCORE

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APPENDIX B:

TABLES

Table 1. Quantitative listings of macroinvertebrates collected 04 September 2012 from six aquatic sample sites for surface mine permit number 1101760 in Wise County, Virginia.

Order	Family	Fall 2012					
		BRFK-1	BRFK-2	BRFK-3	BRFK-4	BCPT-1	BPR-1
Ephemeroptera	Baetidae			2		2	14
	Isonychiidae						3
Plecoptera	Chloroperlidae					1	
	Leuctridae					47	3
	Peltoperlidae					1	
Trichoptera	Hydropsychidae	100	84	51	64	39	70
	Philopotamidae						3
	Rhyacophilidae						
	Uenoidae						
Coleoptera	Elmidae		2		2	6	2
	Psephenidae					3	
Diptera				1			
	Chironomidae	3	13	50	25	3	5
	Empididae			2			
	Simuliidae				1	4	17
	Stratiomyidae		1				
	Tipulidae					1	
Odonata	Cordulegastridae			1			
	Gomphidae	2	1			1	
Megaloptera	Sialidae				2		
Decapoda	Cambaridae	1			1		
Annelida	Oligochaeta		10	15	11		2
		106	111	122	106	108	119

Table 2. VSCI metrics calculated from the macroinvertebrates collected 04 September 2012 at six aquatic sample sites for surface mine permit number 1101760 in Wise County, Virginia

Family Metrics	Fall 2012					
	BRFK-1	BRFK-2	BRFK-3	BRFK-4	BCPT-1	BPR-1
Taxa Richness	4	6	7	7	9	11
EPT Taxa	1	1	2	1	5	5
% Ephemeroptera	0	0	1.64	0	14.29	1.85
% PT - Hydropsychidae	0	0	0	0	5	45.4
% Scrapers	0	1.8	0	1.89	1.68	8.33
% Chironomidae	2.83	11.71	40.98	23.58	4.2	2.78
% 2 Dominant	97.17	87.39	82.79	83.96	73.11	79.63
HBI	5.9	5.95	5.93	5.91	5.39	3.03
VSCI	23.61	25.74	24.54	25.55	41.19	55.16

Table 3. Physiochemical water data collected 04 September 2012 at six aquatic sample sites for surface mine permit number 1101760 in Wise County, Virginia.

Parameter	BRFK-1	BRFK-2	BRFK-3	BRFK-4	BCPT-1	BPR-1
Temperature (Celsius)	18.1	20	19.3	18.8	21	18.5
Specific Conductance (µs)	1338	1388	1366	1368	959	1140
pH	*8.25	*8.4	*8.45	*8.33	*8.27	*8.29
Dissolved Oxygen mg/l)	9.1	8.9	8.88	8.97	8.47	8.47

* = Failed post calibration test

APPENDIX C:
GRAB SAMPLE ANALYSIS